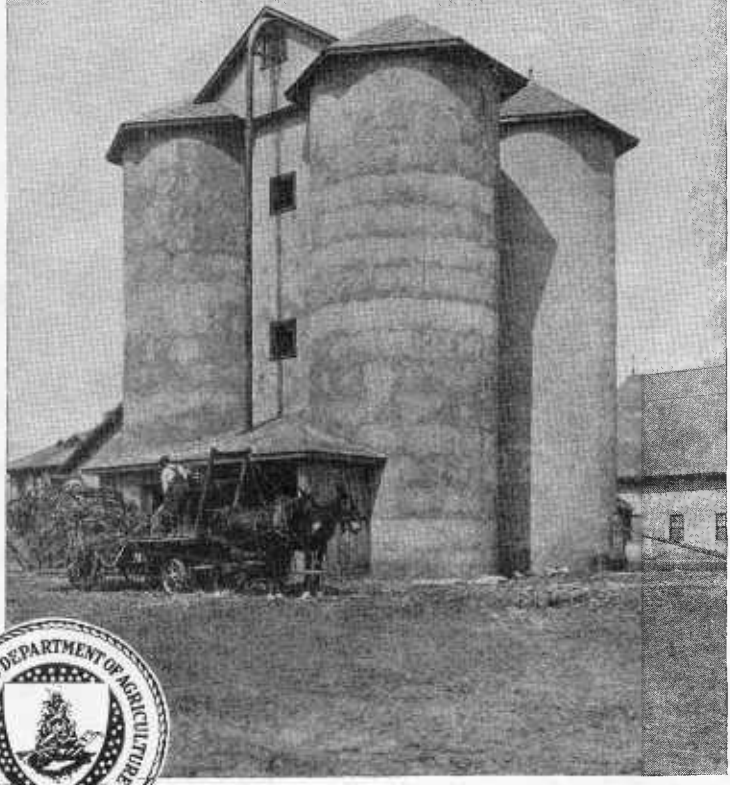
U. S. DEPARTMENT OF AGRICULTURE

FARMERS' BULLETIN No. 578
Dec. 1935

THE MAKING AND FEEDING OF SILAGE



SILAGE occupies an important place in the feeding of livestock. Crops for silage are rarely a total failure as neither drought nor excessive rains prevent the making of at least part of a crop into silage. Some crops can be utilized more efficiently as silage than as dry forage because in the form of silage the entire crop is edible. Apparently, any forage crop can be made into silage, but where corn can be grown successfully it is the outstanding silage crop.

Good quality in the silage depends on cutting the crop at the right stage of maturity, cutting it fine, thoroughly excluding air, and the presence of enough but not too much moisture in the cut material. When silage is rightly put into and carefully removed from the silo, there is no loss from spoiling except on the surface.

Silage is a cheap and economical feed for dairy cattle of all kinds and for beef cattle, from breeding cow to fattening steer. Sheep like it, and it is well suited to their needs. Horses and mules may be fed limited quantities of good silage with good results.

Washington, D. C.

Issued July 1918
Revised December 1935

THE MAKING AND FEEDING OF SILAGE

By T. E. WOODWARD, *senior dairy husbandman, Division of Dairy Cattle Breeding, Feeding, and Management Investigations, Bureau of Dairy Industry;* and W. H. BLACK, D. A. SPENCER, and J. O. WILLIAMS, *senior animal husbandmen, Animal Husbandry Division, Bureau of Animal Industry*[1]

CONTENTS

MANUFACTURE AND FEEDING VALUE OF SILAGE

By T. E. WOODWARD

SILAGE is forage that has undergone an acid fermentation as a result of being packed moist in an airtight container or pit. Silage may be made in silos of various materials, constructed above or below the ground. The different types of silos preserve the silage satisfactorily if air and surface drainage of water are excluded. While silage may also be made in stacks, there is a considerable loss on account of spoilage around the outside, due to exposure to the air.

Some crops can be more completely utilized by being placed in a silo than by being harvested and dried. The stalks of corn, for instance, are all eaten if made into silage, but if they are fed dry much of the material may be wasted. Other crops ordinarily made into hay can be made into silage advantageously if the weather is unfit for the making of hay. Still other materials, such as cannery refuse, cannot well be dried but can be made into silage. Conversion into silage helps to prevent the waste and loss of feed.

Succulence or juiciness was formerly thought to be an important characteristic of silage in promoting the digestive processes and in stimulating the organs of milk secretion. The water adds little to the nutritive value but is essential to the fermentation process. Properly made silage has recently been found to have a high content of carotene, the yellow pigment from which vitamin A is

[1] This publication is a revision of former editions prepared by T. E. Woodward, Bureau of Dairy Industry, and J. B. McNulty, formerly of the Bureau of Dairy Industry; and George M. Rommel, E. W. Sheets, and F. R. Marshall, formerly of the Animal Husbandry Division, Bureau of Animal Industry.

formed in the animal body. Possibly some of the favorable effects which have been observed when silage is fed should be attributed to the content of carotene rather than to the quality of succulence. The carotene content of silage makes it particularly valuable in a ration containing a poorly cured hay.

In those regions of the United States where alfalfa can be grown cheaply, where it can be cured into a good quality of hay, and where a good stand persists for many years, there is little or no advantage in making silage either from the alfalfa or from any other crop. In other regions where corn or sorghum is raised in a rotation of crops or where the weather conditions are unfavorable for the curing of hay the silo fills a valuable place. Much corn, and to a lesser extent sorghum is raised solely for the grain. In case of drought the yield of such grain may be much reduced or be an entire failure. The silo is an excellent place in which to save what forage is produced.

LOSSES OF FOOD NUTRIENTS IN THE SILO

When forage is placed in the silo, fermentation begins almost immediately. The temperature continues to rise for a few days and then gradually subsides. In the process of fermentation lactic and acetic acids are formed from the sugars in the material. Normal corn silage contains about 1.5 percent of acid. The formation of these acids appears to be both necessary and desirable as they help to preserve the silage by inhibiting the growth of certain organisms which cause decay.

Any fermentation beyond that required for the development of acids is detrimental. The extent of fermentation and heating depends upon the amount of air present. It is common knowledge, for instance, that the material at the top of the silo becomes very hot and spoils. Underneath the spoiled material is a layer of dark-colored silage which, although not unfit for feeding, has nevertheless reached a rather high temperature. Any development of heat means a loss of food nutrients, and the greater the heat the greater the loss. As heating depends upon the presence of air, the loss of food nutrients in shallow silos is likely to be greater than in deep ones. Excessive loss can also be expected if the material put into the silo is too dry or coarse to pack well.

With most crops it appears that there is only one condition to look out for in order to have the silage keep and that is exclusion of air. If the air is forced out of the material promptly and kept out, there will be no spoilage. Plenty of moisture and fine cutting cause the material to pack closer and thus force out the air.

The only actual spoilage that cannot be avoided in the silo is that which occurs at the top of the silage. In a silo 14 feet in diameter this spoilage will amount to about 1½ to 2 tons 3 months after filling. With trench silos even this spoilage is sometimes avoided. Tight sides and and careful sealing around the doors should prevent any other spoilage.

Except in the silage at the top, the amount of food nutrients lost through heating and fermentation, is small. According to the results of a study made by the Missouri Agricultural Experiment Station in

1924, these losses of dry matter for various crops are as follows: Corn, 4.01 percent; grass crops, 18.06 percent; peas and oats, 6.90 percent; and legume crops, 2.12 percent. Later investigations with grass silage at the United States Dairy Experiment Station at Beltsville, Md., show that losses from fermentation can be kept below 10 percent.

CROPS SUITABLE FOR SILAGE

By the use of proper methods almost any green forage crop can be made into silage that will keep in good condition, without an excessive loss of food nutrients. Few feeds are improved either in palatability or in nutritive value by undergoing fermentation in the

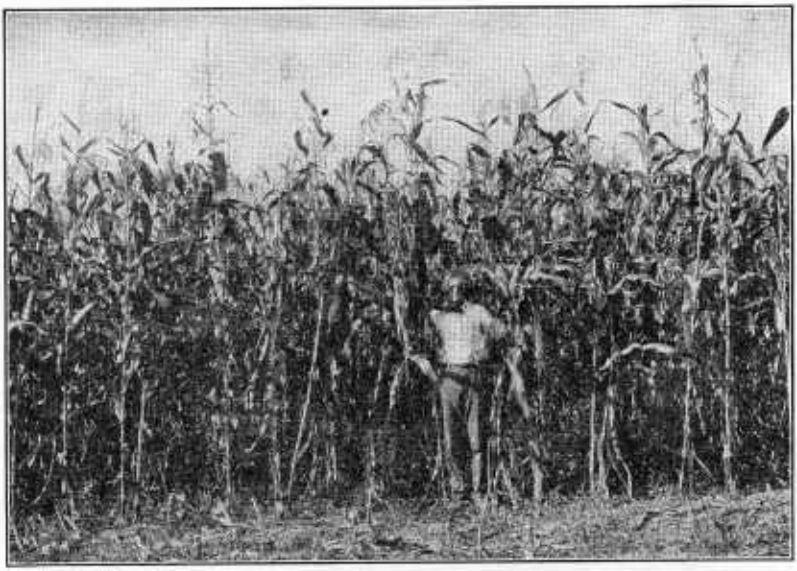


FIGURE 1.—Well-eared corn makes silage of the best quality.

silo; on the other hand, none appear to be affected detrimentally to any marked extent. As a rule, if a forage is palatable and nutritious when it is put into the silo, it will be palatable and nutritious when it is taken out; if it is a poor feed when put into the silo, it will be a poor feed when taken out.

CORN

Corn is the common silage crop wherever it can be grown successfully (fig. 1). Silage made from corn has a good flavor, is very palatable, and will keep in good condition for years. It contains nearly as high a percentage of digestible nutrients as the corn from which it was made. When it is properly siloed, the losses of digestible nutrients from fermentation are smaller than in most other crops.

Throughout a considerable portion of the United States more food material can be obtained from an acre of corn as silage than from an acre of any other crop. Corn is more easily harvested and put into

the silo than crops like rye, clover, cowpeas, or alfalfa, and when cut for silage retains the maximum quantity of nutrients. Experiments at the Missouri Experiment Station have shown that corn, when siloed, loses 4.01 percent of its dry matter as compared with 15.12 percent when cut for fodder and cured in the field. Moreover, there is less waste in feeding silage than in feeding fodder, since good silage properly fed is practically all consumed. For wintering calves 1 acre of corn silage has been shown to be equal to 1.63 acres of dry ground corn fodder, in experiments on feeding beef cattle at the Kansas Agricultural Experiment Station. When corn is cut for silage the land is cleared and left ready for another crop sooner than when the corn is shocked or is husked from the standing stalk. Corn can be put into the silo at a cost not above that of shocking, husking, grinding, and shredding.

In spite of the many strong points in favor of corn as a silage crop, however, it is not a perfect ration, because it is low in both protein and mineral matter. In filling the silo, some other crop, such as clover, cowpeas, soybeans, or alfalfa, is sometimes mixed with corn in order to correct the deficiency of protein. Ordinarily this is not to be advised if the legumes can be made into a good quality of hay.

VARIETIES TO PLANT

As there is a steady increase in all nutrients of a corn crop up to maturity, it is best to plant a variety of corn that will mature sufficiently for silage before frost. Since the corn does not need to be so mature for silage as for grain, it is possible to use a later maturing variety and thus obtain a greater yield than would be obtained from the earlier maturing varieties ordinarily planted for grain. In a 5-year test made at the Ohio Agricultural Experiment Station reported in 1923 it was found that the early maturing corn yielded on an average 10.31 tons of silage per acre, whereas the late maturing corn yielded 11.97 tons. There appears to be little if any advantage in using a variety which produces foliage and stalk at the expense of grain, as the ears contain the most valuable part of the food constituents. Ordinarily the variety of corn which produces the most grain to the acre is the best to use for silage. The greater the quantity of grain in the silage the more nutritious the silage and the greater the saving of concentrated feed used to supplement the silage.

METHODS OF PLANTING

Work done at the Illinois Agricultural Experiment Station as far back as 1890 showed that thick planting results in greater tonnage and in more stalk and foliage in proportion to the ears than does thin planting. When the corn is planted less than about 12 inches apart in rows from 40 to 44 inches apart on good land, the total yield of ears is decreased and the proportion of poor ears to good ears is increased. Planting more than about 12 inches apart on good land increases the proportion of good to poor ears but decreases the total weight of ears. It is thought best to space the planting so as to obtain the greatest total yield of ears. On good land this will be about 12 inches; on poorer land possibly as much as 18 inches. On weedy land it is better to plant in hills so that the corn can be cultivated both ways, in which case the planting may vary from 2 or 3 kernels in

a hill to 3 or 4 kernels, depending on the fertility of the soil. The growth of weeds lowers the yield of corn, but unless weeds are present in great numbers they do not noticeably affect the quality of the silage and therefore can be cut along with the corn and put into the silo.

YIELD

From 4 to 20 tons of silage can be obtained from an acre of corn. A 50-bushel crop of corn yields from 8 to 12 tons of silage an acre, depending on the amount of leaves and stalks that accompany the ears and on the stage of maturity at which it is siloed. The quantity of silage that may be expected per acre is often roughly estimated at 1 ton for each 5 or 5½ bushels of shelled corn. Southern varieties of corn as a rule have a larger proportion of stalks and leaves than northern-grown varieties.

TIME TO HARVEST

Ordinarily corn should be harvested for the silo about 10 days or so before it would be cut for shocking. The most advanced stage of maturity at which corn can be harvested and still make silage of the highest quality from it is when about 90 percent of the kernels are dented and 75 percent or more of the kernels are hardened so that no milk can be squeezed out. At this time the lower leaves on the stalk are turning brown and the green corn fodder contains about 70 percent of moisture, which is sufficient for silage. The corn can rarely all be put in the silo at the exact stage of maturity desired. It is generally better to harvest the corn at a stage that is less mature rather than more mature than that described. Silage made from corn containing moisture enough for proper preservation is more palatable than that made from corn so mature as to require the addition of water.

Table 1, which is based on data taken from the eighth annual report of the New York State Agricultural Experiment Station, shows the steady increase in the yield of food nutrients per acre up to the time the corn is ripe. For this reason the corn plant should be allowed to mature as much as possible and still have moisture enough to pack the corn properly in the silo without the addition of water. Probably the moisture content should not be much below 70 percent or much above 75 percent. Of course, when a large quantity of silage is made and weather conditions are unfavorable the moisture content cannot be kept within these limits.

TABLE 1.—*Chemical changes during growth of corn plant*

Stage of growth and date	Yield per acre	Composition by weight						
		Water	Dry matter	Ash	Albuminoids	Crude fiber	Nitrogen free extract	Fat
	Pounds	*Pounds*	*Pounds*	*Pounds*	*Pounds*	*Pounds*	*Pounds*	*Pounds*
Tasseled, July 30	18,045	16,426	1,619	138.91	239.77	514.19	653.91	72.20
Silked, Aug. 9	25,745	22,666	3,078	201.30	436.76	872.93	1,399.26	167.75
Milk, Aug. 21	32,600	27,957	4,643	232.15	748.69	1,261.97	2,441.29	228.90
Glazed, Sept. 7	32,295	25,093	7,202	302.48	643.86	1,755.85	4,239.82	259.99
Ripe, Sept. 23	28,460	20,542	7,918	364.23	677.78	1,734.04	4,827.60	314.34

IMMATURE AND FROSTED CORN

When weather conditions such as hail, drought, or frost prevent the maturing of corn for the silo, it may be cut while still immature and produce a fair grade of silage. A good practice is to mix such corn with some which is more mature. Silage from immature corn is sourer than that from mature corn, and more laxative when fed in large quantities. Trouble from this source can be avoided by care in feeding.

Frosted corn dries out very quickly, and many leaves are lost in handling. The corn may be so dry, also, that it will not pack well, which necessitates the addition of considerable water at the time of filling. Frosted corn should be cut as soon as possible, in order to prevent excessive drying out. If this is done the stalks may contain sufficient moisture for satisfactory silage without the addition of water. The frosting of the corn causes only a small decrease in the usual feed nutrients, the greatest part being due to the loss of leaves in handling. Frosting, however, does reduce the carotene content of the corn and of the resulting silage to a marked extent.

FIGURE 2.—Shock corn, if properly handled, will make fair silage.

DRY CORN FODDER

Sometimes there is a delay in filling the silo, and it is necessary to cut and shock the corn; also, on farms which have a limited silo capacity, it is often desired to refill the silos after the silage has been fed out. Dry corn fodder (fig. 2) may be siloed successfully, but it is absolutely necessary that water enough be added to make it pack well in the silo. Water may be added by allowing a stream from a hose to flow into the blower or the top of the blower pipe while filling. In addition, it is desirable to sprinkle the surface of the cut material as it is distributed in the silo. Corn-fodder silage is not so palatable nor so good as silage made when the corn is at the proper stage. It also lacks the aroma of good corn

silage. The Missouri Station reports that the water to be added should be of the same weight as the corn fodder. Owing to the large quantity of water required, siloing dry corn fodder is advisable only on farms having a convenient and adequate water system.

Corn stover likewise can be made into silage by the same method. It lacks flavor and palatability and is low in feeding value. It is doubtful whether the making of such silage is an economical practice.

SORGHUMS

The sorgos (saccharine sorghums), such as Amber, Orange, and Atlas "cane" and nonsaccharine sorghums, such as kafir, feterita, milo, hegari, and Sudan grass, are suitable for silage. Sorghums are more dependable and yield more in those regions of the South and West where the rainfall is too light or irregular or the soil too poor for a good growth of corn. For successful silage it is important that sorgo be harvested when the seed has become hard. If harvested earlier, a silage with a high acid content is produced. Experiments made at the Kansas and California Agricultural Experiment Stations indicate that there is no great difference in feeding value between sorghum and corn silage. A mixture of corn and sorghum has proved to be satisfactory in some localities where the rainfall is so variable as to make the corn crop uncertain.

LEGUMES

The legumes include the clovers, alfalfa, cowpeas, soybeans, and vetches. All these may be made into a good quality of silage under proper conditions. It is ordinarily a better practice, however, to make them into hay provided weather conditions permit proper curing. A crop can be preserved more cheaply as hay than as silage because of the smaller weight of water which must be handled and because of the lack of machinery adapted to the easy handling of broadcast crops in the green state.

Legumes have a low content of sugar from which the acids so helpful in the preservation of silage are developed. For this reason greater precautions must be exercised in the making of legume silage than are necessary with the nonleguminous crops. All the legumes may be siloed successfully if mixed with a crop containing much sugar, such as corn or the sorghums; or they may be siloed alone provided the moisture content of the material is sufficiently low. When all conditions are favorable the resulting silage is palatable and the losses of food nutrients no greater than with corn.

At the Kansas Station alfalfa was made into silage successfully by the addition of blackstrap molasses at the rate of 4 or 5 percent by weight. The molasses was said to improve both the palatability and the keeping quality of the silage. At the Missouri Station alfalfa made good silage when the moisture content of the crop ranged between 50 and 70 percent as a result of either allowing the crop to mature sufficiently or partially drying it in the field for a few hours after mowing. On the other hand a greater moisture content resulted in ill-smelling, unpalatable silage, and a considerable loss of food nutrients. Except during a period of low rainfall

alfalfa at the haymaking stage usually contains too much moisture to make good silage.

The Missouri Station also reports that the clovers, soybeans, and cowpeas may be made into good silage provided the moisture content is not too high. Clover for silage should be allowed to become somewhat more mature than when cut for hay. Soybeans and cowpeas should reach the stage when the seeds are well developed and the pods are beginning to turn yellow. If they have not reached this stage they should be allowed to lie in the field until thoroughly wilted.

While cowpeas and soybeans may be siloed separately, a more general practice is to use them in combination with corn or sorghum. They are grown either in separate fields or with the corn. When grown with corn, cowpeas climb the stalks and make harvesting difficult. Soybeans, being self-supporting, can be harvested readily with the corn by means of a corn binder. For this reason and because they can be planted earlier in the season, soybeans make a more satisfactory crop to grow with the corn.

A strong odor is imparted to milk if legume silage is fed to cows immediately before they are milked. It is therefore advisable to feed legume silage immediately after milking.

SMALL GRAINS

When small grains, such as wheat, barley, buckwheat, rye, and oats, are used for silage they should be cut when the kernel is just passing from the milk into the dough stage. It is very important to cut them fine and pack them firmly in the silo. The small grains ordinarily make more palatable silage than the legumes, but are inferior to either corn or sorghum. Because of the early stage at which they must be cut and the normal loss from fermentation, there is a marked loss in digestible nutrients in silage made from small grains as compared with maturing them for grain. It is usually advisable, therefore, to harvest them for grain. Only when corn or sorghum cannot be grown successfully and the need for silage is great is it desirable to cut small grains for silage.

Of these crops, rye especially makes a rather unpalatable silage which must be fed with care to avoid tainting the milk.

FIELD PEAS AND OATS, OR VETCH AND WHEAT

Field peas and oats, or vetch and wheat planted together make a palatable silage high in protein and are particularly adapted to sections of the United States where the climate makes the growing of corn or sorghum uncertain or impossible. The best time to cut oats and peas for silage is when the oats are in the late-dough stage or showing first signs of turning yellow and the pea pods are turning slightly yellow. At this time the crop contains from 60 to 70 percent of moisture, which is an essential condition to success. If cut earlier the crop should be allowed to dry to some extent before it is placed in the silo. Probably wheat and vetch should be harvested at a similar stage of maturity. Fine cutting and thorough packing are necessary when peas and oats or wheat and vetch are siloed together.

GRASSES

Very palatable and nutritious silage can be made from the grasses or mixtures of grasses and clovers that are ordinarily used for pasturage or hay. In certain foreign countries such silage is made rather extensively. The crop should be chopped rather than put into the silo whole. It should be low enough in moisture either naturally or by wilting so that there will be no leakage of juices from the silo. Immature grasses, if wilted, will make a better quality of silage than mature grasses just as such grasses will make a better quality of hay. If properly made, grass silage will have a very high content of carotene. Fine cutting, firm packing, especially around the silo walls, and a moisture content between 50 and 70 percent are the conditions essential to making the best grade of grass silage. It appears that surplus pasturage in the spring may, under some conditions, be made into silage advantageously and this silage fed either later in the summer or the following winter. Experiments indicate that silage made from immature grasses will be eaten in as great quantities as similar grasses will be grazed; also, that the butter from cows fed grass silage will have much the same color as the butter from cows grazing the green grass.

MILLET

The millets are not generally used as silage crops, although those who have had experience with them say that a fair grade of silage can be made if the crop is cut when nearly ripe enough for seed. It should be cut fine and packed firmly in the silo. As a rule, however, the millets are probably more profitable when used as soiling crops or as hays.

PEA VINES

Pea vines from canning factories are used for silage. In feeding value they are about equal to corn silage, being a little richer in protein, but containing about the same quantity of total digestible nutrients. Frequently pea vines are stacked instead of being put into the silo, in which case considerable loss occurs, especially if the stack is opened in warm weather. Stacked pea vines should not be used until cold weather or until such time as the silage can be fed continuously. Pea-vine silage is rather laxative and should be fed with care. Because of its strong odor it should always be fed to milk cows immediately after milking.

BEET TOPS

If properly handled, beet tops and crowns can be made into good silage. The tops should be run through the cutter and put into the silo promptly after the beets are topped. In gathering the tops from the field care should be taken to have them free from dirt, as it damages the silage. Cut straw should be placed in the bottom of the silo to absorb excess moisture, and as fast as the tops are cut straw should be mixed with them. In filling the silo special care should be used to have the edges packed firmly. Salt sprinkled over the contents every few inches of depth increases the palatability of the silage. After filling, a 12-inch layer of cut straw should

be placed on the top to keep the air out. Other coarse roughage, such as corn or cane stover, can be used in place of straw. Water should not be added to the silage.

CANE TOPS AND CANE BAGASSE

Tops from sugarcane have been made successfully into silage. The cane tops and leaves should be run through a cutter before they are placed in the silo. Such silage, although not so good as corn silage, can well be used in those sections where sugarcane is grown abundantly, thus utilizing what otherwise would be wasted. Cane bagasse or pomace also makes a fair quality of silage.

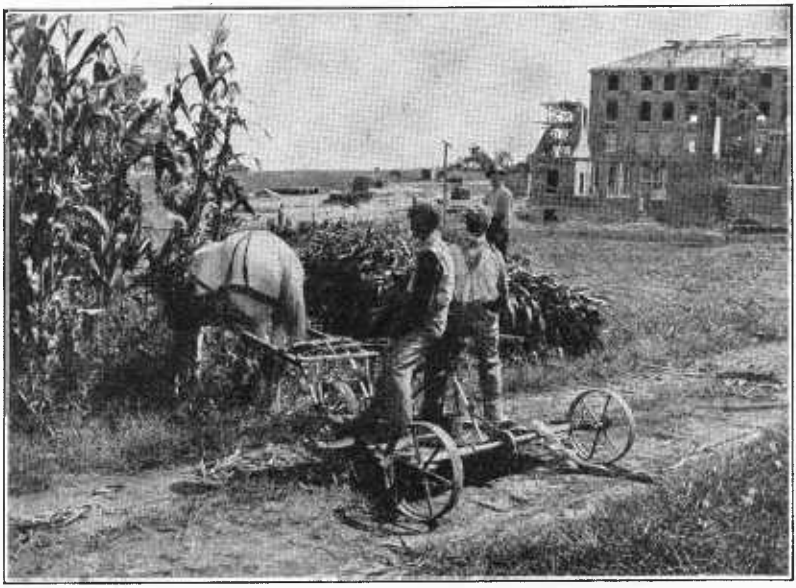


FIGURE 3.—The platform cutter is adapted for use where only a small quantity of silage is to be made.

SUNFLOWERS

Sunflowers are used to some extent in the West and Northwest, where the weather is too cold and the season too short for the best growth of corn. There seems to be a universal agreement among investigators that in some localities sunflowers yield a much greater tonnage than corn. As high as 29.75 tons to the acre has been reported by the experiment station at Huntley, Mont. At that station it was likewise found that when planted in rows 20 inches apart the sunflowers gave greater yields than when planted farther apart. The plants were about 10 inches apart in the rows, and 15 pounds of seed were used to the acre. Unless harvested soon after they come into bloom and before the seeds are developed, the silage will be unpalatable. Sunflowers are not so easily handled as corn, on account of their stiff, brittle stalks, and because the heads tend to clog the feeding rolls of the silage cutter.

Opinions differ as to the feeding value of sunflower silage. In some experiments it seems to be practically equal to corn silage; in others it is inferior. Doubtless the stage of maturity at harvesting time of both the sunflowers and the corn has been partly responsible for this lack of uniformity in results. A composite of all experiments indicates that sunflower silage is neither so palatable nor so valuable, pound for pound, as corn silage, though it may be fully equal to some of the other kinds of silage.

MISCELLANEOUS MATERIALS

Beet pulp, apple pomace, Russian thistle, corn husks from canning factories, and weeds of various kinds are also occasionally used for silage, but in general are not so satisfactory as other crops.

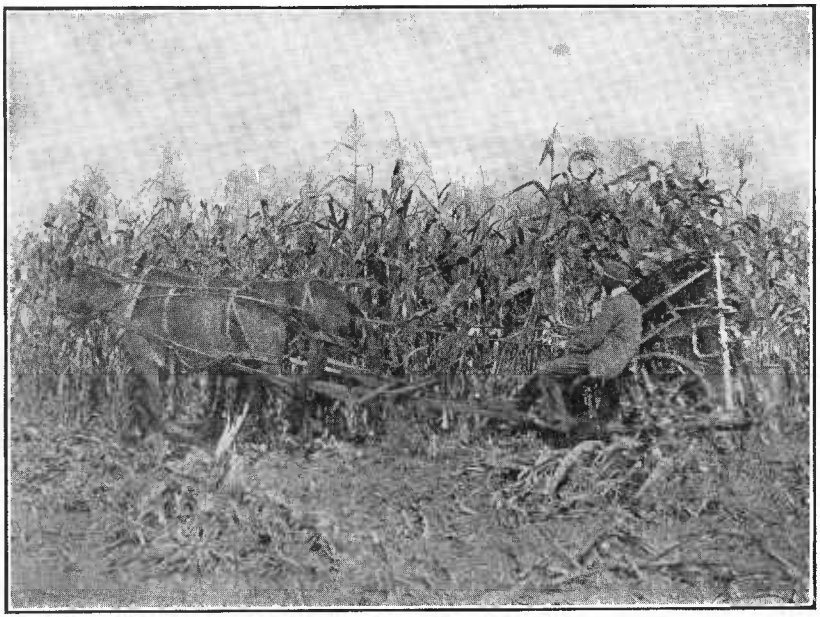


FIGURE 4.—A corn harvester at work.

HARVESTING THE CROP AND FILLING THE SILO

Corn or sorghums for the silo may be cut by hand, by the one-horse, two-row platform cutter (fig. 3), or by the corn harvester and binder (fig. 4). Hand cutting is practiced on farms where the quantity to be cut is too small to justify the purchase of a harvester and when the corn is down or in such position as to preclude the successful use of the platform cutter or the corn harvester. Of the three methods the Nebraska Agricultural Experiment Station found that, all things considered, the corn harvester constituted the most satisfactory method although the cost per acre of cutting corn was the lowest when the platform cutter was used. In case only a small quantity is to be harvested on each farm, several farmers may well cooperate in the purchase of a harvester rather than to do the work by hand.

In using the corn harvester the bundles should be made rather small. While this takes more twine, the extra expense is more than offset by the ease of handling the bundles and feeding them into the silage cutter. The harvester should not get so far ahead of the haulers that the corn will lose any considerable amount of moisture before it reaches the cutter.

A bundle elevator which is attached to the corn harvester in place of the bundle carrier has come into use in the last few years. This elevator delivers the bundles to a wagon driven alongside the harvester. Its use eliminates the hardest part of the silo-filling operation. A load of 2 tons can be put on in from 12 to 15 minutes. When the elevator is used the power necessary to pull the harvester is increased, and this fact, together with the need for steady power, makes the use of a tractor desirable.

Hay and pasture crops and those seeded in drills or broadcast are cut with a mower, raked into windrows with either a side-delivery or dump rake and then loaded on the wagons by hand or with a hay

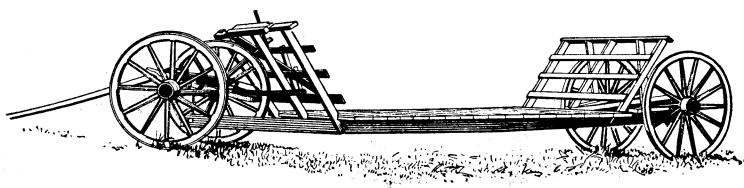


FIGURE 5.—A low rack for hauling corn to cutter.

loader. The green crops often are not handled satisfactorily with the ordinary farm machinery. The rakes pass over much of the material, and the loader fails to pick the windrows up clean. There is now a machine on the market which is said to mow and elevate such crops onto a wagon or truck satisfactorily. It is drawn by a tractor and operated with a power take-off.

HAULING TO THE CUTTER

Ordinarily the corn is hauled to the cutter on a common, flat hayrack. It is best to have this rack mounted on a low-wheeled wagon, even when used in connection with a harvester and elevator. Of course, when the loading is done by hand a low-wheeled wagon is preferable to a high-wheeled one (figs. 5 and 6).

A low rack or body can be made easily. The following directions for making a rack of that kind are taken from Farmers' Bulletin 292, Cost of Filling Silos, now out of print:

> The rack . . . consists of two 4 by 6 inch bed pieces, 18 or 20 feet in length, bolted together at one end to form a V. On top of these timbers is built a rack 6 feet in width. The bottom of this rack is about 8 feet long. The end boards are 4 feet high, built flaring so that they do not quite touch the wheels. The apex of the V is suspended below the front axle of an ordinary farm wagon by means of a long kingbolt. The other ends are attached below the hind axle by U-shaped clevises. . . The materials needed in its construction are 80 board feet of 4 by 6 inch plank, 96 feet of boards 1 by 12 inches, 22 feet of lumber 2 by 4 inches, 1 long kingbolt, 2 stirrup rods, and bolts and nails.

If few teams are available and the haul is long, the load should be as large as possible. With plenty of teams and a short haul the loads should be smaller, thus saving the labor of high lifting in loading and facilitating the work of unloading.

CUTTING THE SILAGE

A number of satisfactory silage cutters are on the market. The chief feature to be considered in a cutter is whether or not it is strongly made and will handle both hay and forage crops. The capacity is important. The mistake is often made of getting one that is too small, thus making the operation of filling the silo very

FIGURE 6.—Loading corn on the wagon.

slow and interfering with the continuous employment of the entire force of men. It is better to get a machine large enough so that everyone will be able to keep busy all the time. The larger cutters are equipped with self-feeders, a labor-saving device which the smaller sizes may not have. Other factors to be taken into account are the amount of work to be done and the power to be used.

The usual length of cutting varies from one-fourth of an inch to 1 inch. The latter is a little too long, as the pieces do not pack so closely in the silo and they are not so completely consumed in feeding as the shorter lengths. On the other hand, the longer the pieces the more rapidly the corn can be run through the cutter. Probably most silage is now cut into pieces not over half an inch long. All of the hay and small-grain crops should be cut as fine as possible.

ELEVATING THE SILAGE

The blower pipe should be as nearly perpendicular as possible (fig. 7), to reduce to the minimum the friction of the cut corn on the inside of the pipe and thus lessen the danger of clogging. If it is not possible to place the silage cutter close to the silo, it is well to keep the blower pipe nearly vertical but to extend it high enough so that the cut corn from the top of the pipe will run into the silo at an angle of about 45°. Horizontal pipes are especially liable to clog if the corn is wet or if it is fed into the cutter rapidly.

FIGURE 7.—Silage cutter with blower.

POWER REQUIRED

The power necessary to operate the cutter depends on the width of the cutter throat, the sharpness of the knives, the height of the silo, the rate of feeding, and the condition of the corn as regards ears and moisture. Less power is required if the cutter is fed below full capacity. It is advisable to have sufficient power to run the cutter at full capacity, and many prefer to have a little surplus power. The figures in table 2 represent the minimum power needed to run cutters at near their capacity. A smaller engine will necessitate slower feeding, especially with heavy, well-eared corn. This table has been prepared from manufacturers' statements, personal observations, and experience, and is not the result of actual experimental tests.

TABLE 2.—*Horsepower (gas engine[1]) required to operate silage cutter and blower with cutter throats of varying widths and silos of varying heights*

Width of cutter throat (inches)	Horsepower required to elevate silage—													Approximate capacity
	24 feet	26 feet	28 feet	30 feet	32 feet	34 feet	36 feet	38 feet	40 feet	42 feet	44 feet	46 feet	48 feet	50 feet	
															Tons per hour
10	10.5	10.7	10.8	11.0	11.2	11.3	11.4	11.6	11.8	12.0	12.1	12.2	12.4	12.7	4
12	13.1	13.3	13.6	13.8	14.0	14.1	14.4	14.6	14.8	15.1	15.2	15.4	15.6	15.9	5
14	15.8	16.1	16.5	16.8	17.1	17.4	17.7	18.1	18.4	18.7	19.1	19.3	19.6	20.2	7
16	18.5	19.0	19.4	20.0	20.5	21.0	21.5	22.0	22.5	23.0	23.5	24.0	24.5	25.0	9
18	21.6	22.2	22.8	23.4	23.9	24.6	25.1	25.8	26.4	26.9	27.4	28.1	28.6	29.3	11
20	25.6	26.1	26.5	27.0	27.6	28.0	28.4	28.9	29.4	29.8	30.3	30.8	31.4	31.8	13
22	28.6	29.7	30.6	30.8	31.4	31.8	32.4	32.8	33.4	33.9	34.4	34.9	35.3	35.8	15
24	33.1	33.6	34.2	34.8	35.4	36.6	36.0	37.2	37.5	38.0	38.5	39.2	39.8	40.3	17
26	36.6	37.3	38.3	39.0	39.7	40.8	41.6	42.3	43.2	44.1	44.9	45.6	46.5	47.3	19

[1] If a steam engine is used the horsepower ratings may be 25 percent less than the figures in the table. In an electric motor is used the rated horsepower may be 15 percent less than the figures in the table.

PACKING THE SILAGE

Ordinarily the blower empties the cut corn or other material into the top of the silo, where one or more men distribute and tramp it down. Unless the material is distributed, the leaves are blown to one side of the silo. The common practice is to keep the sides slightly higher than the center and to tramp the whole surface thoroughly, especially around the edges. Experiments at the Bureau of Dairy Industry farm at Beltsville, Md., show that tramping may be entirely dispensed with. The experiments show also that if the corn is put in the silo at the proper stage of maturity, distributing the silage is unnecessary for perfect preservation. However, in feeding out silage which has not been distributed, it is desirable to take a layer off the entire top of the silage at each feeding; otherwise there is likelihood of getting a batch of silage which contains a preponderance of either leaves or the heavier constituents of the corn plant.

The tramping of such crops as corn and sorghum appears to be a waste of time and effort, but the proper distribution within the silo is desirable.

Chopped grasses and legumes tend to hang together more than chopped corn, and for this reason do not in settling press so tightly against the sides of the silo. This leads to spoilage around the outside. It is thought best to tramp such crops, especially near the walls.

Various contrivances have been used for distributing the cut material, the one commonly recommended being a metal pipe put together loosely in sections. The cut corn from the blower passes down the pipe into the silo, and the pipe, being flexible (fig. 8), can be swung so as to place the material anywhere in the silo. With this contrivance it is not necessary to handle the material with a fork; 1 man can easily do the work of 2. Very little loose material flies about in the silo, and the work is much cleaner. Another advantage is a lessening of the chance that the man in the silo will be struck by some object which may be blown up the blower pipe. As the silage rises in the silo the distributor pipe, which is put together in sections, can readily be shortened.

One of the products of silage fermentation is carbon dioxide. This gas is heavier than air and for this reason tends to displace the air in the silo above the surface of the silage. If there are no doors or other openings to permit the carbon dioxide to flow off, it may collect on top of the silage. As this gas will not support respiration, a person entering the silo may be overcome from lack of oxygen. Before going into a partly filled silo early in the morning during silo-filling operations, it is best to run the blower for a few minutes.

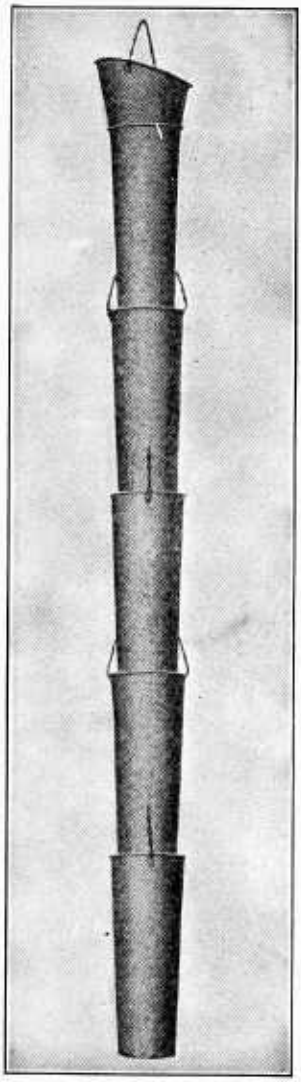


FIGURE 8.—Jointed-pipe silage distributor.

While the corn or sorghum silage appears to pack just as well without tramping as with tramping at the lower levels, this is not the case at the top. The top should be leveled off, and then thoroughly tramped especially around the sides. After about 2 days settling the leveling and tramping should be repeated.

ADDING WATER

In case the material to be siloed has become too dry, water should be added to supply the deficiency of moisture necessary to make it pack properly. Enough water should be added to restore the moisture content of the corn to what it would be if cut at the proper stage.

The water may be applied by means of a hose and spray nozzle, directly on the silage in the silo as it is filled; or it may be run into the blower. In the latter way the water is more evenly mixed with the cut material. When very dry fodder is siloed it is probably better to use both methods in order to wet the fodder sufficiently.

Unless the corn is very green it is a good practice to wet the top of the silage thoroughly as soon as the silo is full and has been leveled off. This helps to pack the top layer and to lessen the spoilage.

ADDING ACID

A. I. Virtanen, of Finland, has developed a method of making silage, called the A. I. V. process, which consists in adding a certain quantity of dilute hydrocholoric and sulphuric acids to the material as it is being placed in the silo. The acid is prepared by diluting the concentrated acids with five times as much water by volume. The amount added varies from 4 to 10 or more percent, depending largely upon whether the crop to be preserved is a legume or not. The object is to bring the acidity of the material quickly to a point at

which undesirable fermentations will be checked or prevented. It is claimed that silage made by this method has a high content of vitamins and that the protein is preserved with practically no loss.

The extent to which this method may be profitably employed in this country has not yet been determined. However, it is known that silage properly made from corn, oats and peas, and grass without the addition of acid has a high content of carotene and that the losses of other feed nutrients are not excessive. Alfalfa silage appears to vary considerably in carotene content, and if it contains more than 70 percent moisture the odor may be offensive. Laboratory tests and short feeding trials show that the addition of acid improves

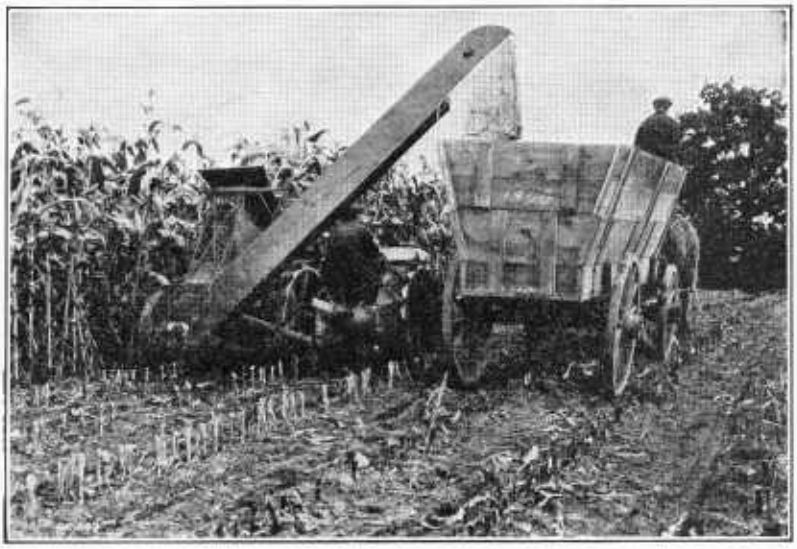


FIGURE 9.—Harvesting the corn by the field-chopping method. (Courtesy of Central Experment Farm, Ottawa, Canada.)

the carotene content of silage made from alfalfa, that it prevents the putrefactive fermentation of high-moisture alfalfa silage, but that it lowers the palatability of the silage.

FIELD-CHOPPING METHOD OF MAKING SILAGE

The field-chopping method of silo filling has been used to some extent in the last few years. The standing corn is harvested and cut into proper lengths for the silo by a machine drawn by a tractor and operated by means of power from the tractor (fig. 9). The cut corn is delivered to a wagon box drawn alongside. It is then hauled to the silo and pushed off into a blower which elevates it into the silo (fig. 10). With a pit silo the material can be dumped directly into the silo. This method of making silage is the easiest known. It is about as rapid and requires approximately the same size crew as when a harvester and bundle elevator are used. It is easier, however, because the labor of placing the bundles on the wagon is saved and because pushing the cut material into the blower is easier than throwing the corn bundles into the cutter. It is probable also that

this outfit will operate successfully on softer ground than will the harvester and elevator on account of the mechanism being operated by power from the tractor. A disadvantage of the field-chopping system is that the corn may be blown down so that hand cutting must be resorted to, in which case the ordinary kind of silage cutter must be used. Another disadvantage is the greater cost of this outfit as compared with that of a corn harvester and silage cutter.

FIGURE 10.—Transferring the cut corn to the silo by the field-chopping method. (Courtesy of Central Experiment Farm, Ottawa, Canada.)

COVERING THE SILAGE

Formerly it was a common practice to cover the silage with some material, such as dirt or cut straw, in order to prevent the top layer from spoiling. At present the covering, when there is one, usually consists of a layer of cut corn from which the ears have been removed. The heavy green stalks pack much better and exclude the air more effectually than straw. Chopped weeds or other materials of little or no feeding value are sometimes used. If the filling of a silo is interrupted for more than 2 days, the top layer will spoil. This spoiled material can be thrown off and used later to put on top of the silage. The top should always be thoroughly tramped and, if convenient, should be wetted down. Sometimes oats are sown on the top before it is wetted. The heat generated by the fermenting mass causes the oats to sprout quickly and form a sod, which helps to keep the air out of the silage beneath. The disadvantage of this method is that the silage spoils before the oats sprout. Whenever possible it is better to begin feeding from the silo as soon as it is filled. If this is done, no covering is necessary and there should be no loss on account of spoiling, provided the feeding is sufficiently rapid.

FEEDING VALUE OF SILAGE

COMPOSITION

The chemical composition and the nutritive value of silage vary according to the crop from which it is made, the degree of maturity of the crop, and other factors (table 3). In general the composition is similar to that of the green crop from which it is made.

TABLE 3.—*Average digestible nutrients per 100 pounds of silages and other succulent feeds*

[Compiled in the Bureau of Chemistry and Soils and the Bureau of Animal Industry]

Material	Total dry matter	Digestible nutrients			
		Protein	Carbohydrates	Fat×2.25	Total
	Pounds	*Pounds*	*Pounds*	*Pounds*	*Pounds*
Green-corn fodder, dent, kernels glazed	26.6	1.1	15.1	1.5	17.7
Corn silage, well matured	26.3	1.4	16.9	1.7	20.0
Green-sorgo fodder	22.7	.5	12.4	1.6	14.5
Sorgo silage	22.4	.2	10.6	1.5	12.3
Uncured red clover	29.2	3.0	14.8	1.6	19.4
Red clover silage	28.0	2.1	11.4	1.7	15.2
Uncured soybeans	24.9	3.1	11.0	1.2	15.3
Soybean silage	27.9	2.5	11.0	1.8	15.3
Uncured cowpeas	17.5	2.6	8.1	.7	11.4
Cowpea silage	22.2	1.1	8.2	1.0	10.3
Uncured peas and oats	22.2	2.5	10.9	1.2	14.6
Oat and pea silage	26.3	2.5	12.7	2.0	17.2
Mangels	8.8	1.1	5.8	.2	7.1
Sugar beets	13.5	1.1	10.1	.1	11.3
Sugar beet pulp (wet)	9.5	.5	6.7	.2	7.4
Sunflower silage	22.1	.9	9.6	2.8	13.3

PALATABILITY

Palatability is a matter of importance because it induces a large consumption. As silage is usually one of the cheapest feeds on the farm, the more silage the livestock eat the greater the saving of more expensive feeds and the more economical the ration. Some green feeds may be made either more or less palatable by converting them into silage. In general, however, the palatability of the silage is similar to that of the green crop from which it is made. Fortunately, good corn silage is quite palatable. Cattle generally eat it in preference to hay or other dry forage.

SILAGE FOR DAIRY CATTLE

By T. E. WOODWARD

Silage has been found to be particularly well adapted as a feed for dairy cows, and in consequence silos are more numerous on farms devoted to dairying than on any other kind of farms. In many sections silage has come to be the dairy farmer's main reliance for winter roughage.

SUPPLEMENTARY FEEDS

Although corn and sorghum silages are excellent feeds, they are not complete feeds for dairy stock. They are too bulky and contain too little protein and mineral matter to meet fully the requirements

of the dairy cow. It is best to feed them with some leguminous hay, such as clover, soybean, or alfalfa. These supply the deficiencies of silage in protein and mineral constituents. However, a ration of silage and hay alone is still too bulky to be satisfactory for other than dry cows or those giving not more than a medium quantity of milk. Under most conditions cows cannot consume enough of these two feeds to support a liberal flow of milk and maintain their body weight. They must have some concentrated feed.

Silage made from legumes and young grasses may contain enough protein so that there will be no need for providing any further quantity in the grain ration. On account of the bulkiness of these silages, however, it will be necessary to feed a concentrate to supplement them.

RATIONS

A good rule to follow in the feeding of corn silage is to allow each cow about 3 pounds of silage a day for each 100 pounds of live weight. For example, give an 800-pound cow 24 pounds of silage, a 1,200-pound cow 36 pounds of silage, and so on. Along with this give the cow all the hay that she will eat. The quantity of grain to feed depends on a number of factors, chief of which are quantity and quality of milk yield and kind and quality of hay fed. The quantity of silage stated above and all the good legume hay the cow will eat twice a day will support a milk yield of from 10 to 16 pounds, depending on the richness of the milk. Consequently cows giving these quantities require no grain. For the production of milk above these quantities the nutrients must be provided in the grain. About 0.4 pound of grain is required to provide the nutrients for the production of 1 pound of milk testing 3.5 percent or less butterfat, 0.5 pound for milk of medium richness testing 4 to 4.5 percent, and about 0.6 pound for milk testing more than 5 percent. For example, if a cow is giving 25 pounds of milk testing more than 5 percent, 10 pounds of this will be provided for by the roughage, whereas 15 pounds must be provided for by the grain. The quantity of grain needed, therefore, is 15×0.6, or 9 pounds. If a cow is giving 36 pounds of milk testing 3.5 percent or less, 20 pounds must be provided for by the grain. The quantity of grain needed for this cow, therefore, is 20×0.4, or 8 pounds. Coarse or poorly cured hay is not consumed in such quantities as good legume hay. Consquently when inferior hay is fed the grain allowance must be increased.

TIME TO FEED

Corn silage usually affects the flavor and odor of milk, according to results of experiments described in United States Department of Agriculture Bulletin No. 1097, and other silages will probably have a similar effect. The influence may be somewhat more pronounced with some silages than with others. All silages should be fed after rather than before milking.

RATE OF FEEDING

When silage is exposed to the air in warm weather it spoils quickly. For this reason a uniform layer should be removed from the top every day. In summer this layer should be not less than 3 inches

thick, but during cold weather feeding may be as slow as desired. Except for some drying on the surface, silage from which the top had been fed has been known to keep in perfect condition for a month or longer in winter.

FEEDING FROZEN SILAGE

Frozen silage must be thawed before being used; it should then be fed immediately, before decomposition sets in. No harm will result from feeding, nor is the nutritive value known to be changed in any way.

SILAGE FOR CALVES, BULLS, AND DRY COWS

Although silage has been fed successfully to vigorous young calves as soon as they would eat it, and in as large quantities as they would consume, there is some evidence that it should be omitted from the ration until the danger of serious digestive disturbance is past, say 60 or 90 days, after which it may be fed safely in quantities up to the capacity of the calf. Yearling heifers consume about half as much as mature stock, that is, from 12 to 24 pounds a day if they are well grown. When the silage is supplemented with some good leguminous hay, no grain is required to keep the yearlings in a thrifty, growing condition.

Some breeders of dairy stock think that a large allowance of silage is detrimental to the breeding qualities of the bull. Whether there is scientific foundation for this opinion remains to be determined. Probably it is a good plan to limit the allowance to about 12 pounds a day for each 1,000 pounds of live weight. When fed in this quantity, silage is thought to be a good, cheap, and safe feed for bulls. It should be supplemented with hay, of course, and with grain also, especially in the case of bulls in active service or growing rapidly.

When cows are dry they consume almost as much roughage as when they are producing milk. Silage may well form the principal ingredient of their ration; in fact, with from 25 to 40 pounds of silage and from 5 to 8 pounds a day of clover, soybean, or alfalfa hay, the cows will keep in good flesh and even gain in weight. Dry cows in thin flesh should always receive some grain.

SILAGE FOR SUMMER FEEDING

One of the most trying seasons of the year for dairy cows is the latter part of summer and early fall. At this season the pastures are often short or dried up, and it is a common mistake of dairymen to let their cows decrease in milk flow because of the shortage of feed. Later in the fall it is impossible to restore the milk flow, no matter how well the cows are fed. On good dairy farms the milk flow of the cows is maintained at as high a level as possible, from parturition to drying off. It becomes necessary, therefore, to supply some feed in addition to pasture grass. The easiest way to do this is to feed silage, which is cheaper and decidedly more convenient to use than soiling crops. How much to feed depends on the condition of the pastures, the quantity varying all the way from 10 pounds to a full winter feed.

Early hay crops or surplus spring pasturage may be made into silage advantageously, provided weather conditions are unfavorable for curing such materials into hay. The silage can then be fed as a supplement to pastures. One advantage of grass silage used in this way is that the same silo used for storing winter feed can also be used for storing summer feed.

SILAGE FOR BEEF CATTLE

By W. H. Black

Although beef cattle are perhaps better adapted than other kinds of domestic animals to utilize coarse roughage in their rations, they cannot fully utilize the dry stems of many mature plants. Cattle frequently eat only the leaves and other finer parts of certain forages and refuse the coarser portions which usually make up a considerable percentage of the plant. In the case of some varieties of soybeans, as much as 25 percent of the hay, in the form of coarse stems, is refused by cattle. In feeding corn stover, 50 percent of the roughage is often refused. However, when such products are made into a good quality of silage, the coarsest stalks and stems are consumed. According to investigations conducted at the Missouri Agricultural Experiment Station, a given acreage of corn made into silage will maintain approximately 50 percent more cattle than the same acreage fed as dry fodder including the ears.

The economy of making such roughage into silage for beef cattle depends on the relation of the summer and winter feed supply. In areas such as the South and the parts of the West having only a light snowfall, where winter grazing can be depended upon extensively, there is relatively little advantage in harvesting feed and storing it as silage, except for emergencies. A similar situation exists on most farms in the Corn Belt, because most of the land is in grain crops, and the stalk fields and straw stacks ordinarily carry more cattle through the winter than the available pastures will supply grazing for in the summer. But on farms having relatively large areas for summer grazing and rather limited capacity for supplying roughage for winter use, there are considerable advantages in using the cultivated acreage for the heaviest yielding crops such as sorghum and corn. The grower gets the maximum feeding value from such crops by making them into silage when the grain is essentially mature but the plant still green (fig. 11).

Even on farms and ranches where winter grazing and harvested dry roughage are fairly abundant and cheap, it is important to provide some silage for beef cattle. Since silage will keep indefinitely without appreciable deterioration if it does not dry out or come in contact with the air, it affords good insurance in case of drought.

The quantity of silage required in a ration depends somewhat on the water content, which is quite variable, and the quantity of grain in the silage when it is made. Ordinarily 100 pounds of silage contains approximately 70 pounds of water and only 30 pounds of dry matter. On the other hand 100 pounds of hay which has gone through the sweat contains nearly 90 pounds of dry matter. Hence it takes approximately 3 pounds of silage to equal 1 pound of hay.

This is a safe rule to follow in estimating the quantity of silage to feed when one knows the hay requirements. With respect to the percentage of protein, crude fiber, starch, sugar, and fat in the dry matter, corn silage is very similar to the hays made from plants such as timothy, Sudan grass, and the wild prairie grasses. The chief difference is that the dry matter of corn silage has less crude fiber and more starch than the hay on account of the ears, which make up nearly 50 percent of the weight of the mature corn plant. Therefore, as proved in practice, one may feed 3 to 6 pounds of corn silage per 100 pounds of live weight of cattle for the same purpose that one would feed 1 to 2 pounds of grass hay per 100 pounds live weight, with about the same results.

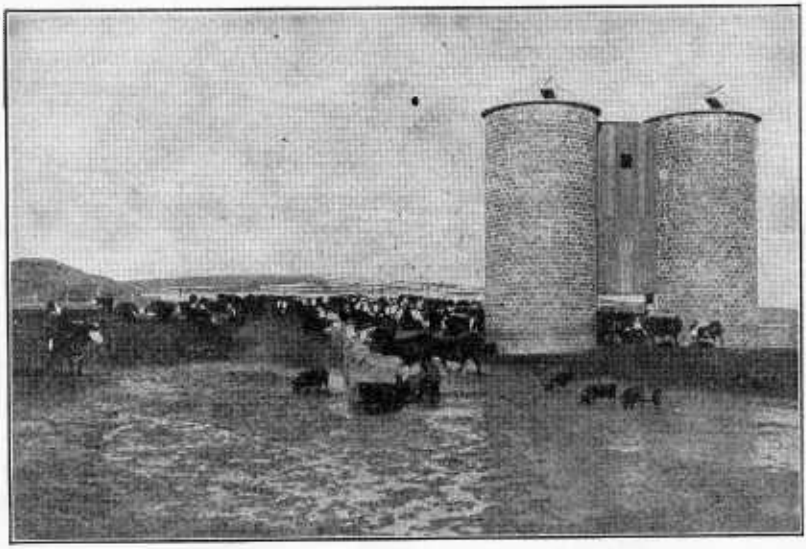


FIGURE 11.—Feeding certain crops in the form of silage to beef cattle enables the owner to obtain the maximum feeding value.

SILAGE FOR THE BREEDING HERD

A good ration for beef cows that are suckling calves may be made with about 30 pounds of corn, sorghum, or other nonlegume silage, 7 pounds of a leafy legume hay, and 3 pounds of straw or stover. If such hay is not available, a protein concentrate such as cottonseed, linseed, or soybean meal may be purchased if the required protein is cheaper in that form than in hay. Under such circumstances, a good ration consists of 40 pounds of silage, 6 pounds of straw, and 1½ pounds of protein concentrate. Such protein supplements are not necessary for legume silage or for silage containing 1 part in 3 or a larger proportion of legumes. For dry cows, silage and low-grade dry roughages, such as coarse hay, straw, and stover, may be used almost exclusively, thus reducing the cost of wintering considerably. Experimental work with corn silage for wintering beef cows at the Pennsylvania Agricultural Experiment Station shows that although oat straw may be used advantageously to cheapen the

ration, it should not make up more than one-third of the total weight of roughage fed.

Generally, good results are obtained in feeding a breeding bull half as much silage as is given to a cow. Bulls should be fed some grain, or a protein concentrate, or both, in the wintering ration to put them in condition for the breeding season. The quantity of grain which should be fed will be determined by the condition of the animal, but should not exceed the proportion of 1 pound of grain to each 100 pounds of live weight. One-third or two-thirds of a pound for each 100 pounds will usually be satisfactory. For example, a 1,400-pound bull on good pasture will keep in excellent breeding condition if he receives about 5 pounds of grain a day. In winter, when there is no pasture, he will probably do well with about 20 pounds of silage, 10 to 15 pounds of good-quality alfalfa or other legume hay, and 5 to 7 pounds of grain. If a protein concentrate is fed, 1 or 2 pounds per day will be sufficient ordinarily, but in any event not more than 4 pounds a day should be fed.

SILAGE FOR BEEF CALVES

Although it is not likely that young calves that are getting plenty of milk will eat enough silage to cause any digestive disturbance, it is considered best to allow them only small quantities along with other feeds. Particular care should be taken to see that the silage fed to calves is free from mold, as the calf's digestion is easily upset by improper feeding. If calves are to be fed silage, they should be fed only a small quantity at first when about 2 months of age. The silage should be increased very gradually, so that not more than 8 pounds are consumed daily by the time the calf is weaned, at 8 to 9 months of age. After they are weaned the amount of silage as well as other feeds depends upon the use to be made of the calves. If they are to be finished at 12 to 15 months of age, the ration of silage usually should not exceed 8 pounds per head at any time during the fattening period. To keep spring calves growing during their first winter with only a moderate loss in condition, 15 pounds of corn silage and 5 pounds of leafy legume hay constitute a good ration.

SILAGE FOR WINTERING STEERS AND HEIFERS

Steers 2 years old or over, or other mature beef cattle, may be wintered almost exclusively on good-quality silage with a small quantity of dry roughage, such as straw or stover. Younger cattle which have to be grown out require some protein, which may be supplied either in the form of a concentrate or as a legume hay. Steers naturally require somewhat less protein than heifers being grown to add to the breeding herd, and those which have been bred.

The rations given in table 4 are suggested for steers and spayed heifers, and for heifers to be used in the breeding herd.

TABLE 4.—*Suggested rations for yearling steers or spayed heifers and for heifers that are to be added to the breeding herd*

[Quantities of feeds are for each 100 pounds of live weight]

Feeds in ration	Average daily quantity of feed for—			
	Steers or spayed heifers		Breeding heifers	
	Ration 1	Ration 2	Ration 3	Ration 4
	Pounds	*Pounds*	*Pounds*	*Pounds*
Corn silage	35	35	35	30
Wheat straw	8	----	6	----
Protein concentrate	1.5	----	2.5	----
Mixed or legume hay	----	5	----	8

SILAGE FOR FATTENING BEEF CATTLE

In fattening cattle, the problems of feeding are very different from those of maintaining and growing cattle. In maintenance and growing rations, an adequate supply of the necessary proteins, minerals, and vitamins, with enough net energy value to enable the animal to move about and keep up its vital processes, are the principal essentials. On most farms those requirements can be supplied most cheaply by feeding rations consisting very largely of coarse roughages, which contain much indigestible crude fiber and have little or no market value. Although such roughages are rather difficult to digest, the energy required to do the work of digestion helps to keep the animal warm. In fattening, on the other hand, while the requirements for protein, minerals, and vitamins are about the same per unit of body weight, a ration containing much more net energy is required. Hence feeds are included which contain relatively high percentages of readily digestible starch, sugar, and fat. The use of such feeds makes it possible for the animals to store the surplus of nutrients in the form of increased muscular tissue and deposits of fat. The more rapid the resulting gains in weight, the smaller the proportion of the feed used for maintenance, which tends to reduce the cost of gains.

Therefore, when concentrates such as grain and the oil meals are relatively cheap, the most economical gains are produced by feeding as much of these as the cattle will eat and just enough of the roughages to supply bulk and also minerals and vitamins not adequately available in the concentrates. But when the concentrates are relatively expensive it is more economical to use a larger proportion of the cheaper roughages and feed the cattle over a longer period to reach the same degree of finish.

In considering the use of corn silage to fatten cattle, one should keep in mind that ordinary corn silage contains almost as much grain as roughage, when calculated on a dry-matter basis. In the Corn Belt the average is approximately 6 bushels per ton. At the Indiana Agricultural Experiment Station, the average of 8 years of feeding trials showed that a ton of silage replaced 4.6 bushels of corn and 613 pounds of clover hay when fed to 2-year-old steers in a ration composed of shelled corn, cottonseed meal, clover hay, and silage, in place

of one made up of shelled corn, cottonseed meal, and clover hay. The average daily feed consumed by these steers weighing on an average 983 pounds and fed the approved silage ration for an average of 158 days in the feeding trials was as follows: Shelled corn, 13.3 pounds; cottonseed meal, 2.8 pounds; clover hay, 3.2 pounds; and silage, 27.4 pounds.

The Illinois Agricultural Experiment Station and a number of cattle feeders have had remarkable success in removing the ears from the green stalks to make a concentrated silage for fattening cattle and using the green stalks for stockers or breeding cattle either as pasturage or as silage. Somewhat better returns were obtained from ear-corn silage made early in September, when the ears contained 53 percent moisture, than from that made late in September, when the ears contained 37 percent moisture. As silage made from green corn containing about 50 percent of moisture packs and keeps well, corn containing less than that amount should have enough water added to bring the moisture content up to 50 percent.

Feeder calves weighing about 450 pounds each will consume approximately 22 pounds of ear-corn silage, 1.5 pounds of cottonseed meal, and 2 pounds of alfalfa hay per head daily for a feeding period of 200 days. On this ration they will make somewhat greater gains per day than calves on a similar ration containing an equivalent amount of corn-and-cob meal. In addition to the more rapid gains and the greater returns per bushel of corn, the making of ear-corn silage has such advantages as making it possible to harvest the corn crop, pasture the stalk fields, and do fall plowing 1 to 2 months earlier than when the corn is left to mature in the field. Incidentally, the green stalks may be plowed under in time for the seeding of winter cereals or made into stover silage for wintering cattle. Fully 50 percent more of the corn-stover silage than of ordinary corn silage is required for a maintenance ration with at least a pound of some protein concentrate for each 100 pounds of live weight.

Fattening experiments conducted at the Michigan and Ohio Agricultural Experiment Stations show that an acre of corn fed as silage will produce fully 50 percent more beef or beef and pork combined than an acre fed as shock or husked corn. The relative profitableness of the two methods depends upon the prices of grain and roughage, their availability, and the cost of harvesting and feeding the corn. The cattle fattened on shock corn at the Michigan station refused about one-third of the stalks.

A 5-year survey in several of the principal cattle-fattening sections of the Corn Belt showed that silage is used much more extensively when grain and other concentrates are high in price than when such feeds are relatively low in price and that farmers are more favorable toward the use of silage for feeder steers weighing less than 750 pounds than for steers weighing over 750 pounds. This survey also showed that silage is used more extensively in the eastern part of the Corn Belt, where the quantity and quality of the legume hay that can be produced locally from year to year are uncertain factors. In the western part of the Corn Belt, where alfalfa is a particularly dependable crop, silage is not used so extensively in fattening cattle. There was a marked tendency for farmers feeding large numbers of steers and not having enough hay of their own pro-

duction to use silage rather extensively. Farmers fattening not more than a carload of steers made less extensive use of silage. This emphasizes the value of silage as a dependable source of roughage.

Experiments have shown that a certain quantity of dry roughage should be fed in rations containing silage. Steer-fattening rations containing considerable quantities of silage are shown in table 5.

TABLE 5.—*Average steer-fattening rations*[1] *containing silage*

Feeds in ration	Quantity of feed daily for steers weighing—			
	550 pounds	650 pounds	800 pounds	900 pounds
	Pounds	*Pounds*	*Pounds*	*Pounds*
Silage	15 to 20	35 to 40	45 to 50	25 to 30
Legume hay (clover, alfalfa, etc.)	1 to 2	2 to 3	3 to 4	6 to 8
Nonlegume hay (grass hay, stover, or straw)	3 to 4	2 to 3	----------	----------
Protein concentrate[2] (cottonseed meal, linseed meal, or soybean meal)	1 to 2	1 to 2	1 to 2	----------
Corn (shelled or broken ear)	5 to 7	6 to 8	6 to 8	12 to 15

[1] Quantities of feed are the average ration for the entire period.
[2] If velvetbeans (in pods) are used, 2½ pounds will be found approximately equivalent to 1 pound of cottonseed meal.

These rations are the average quantities of feed per day for the whole feeding period. Examples of how the quantities of silage and other feeds should vary during the feeding period are given in table 6. Moreover, the sample rations in table 4 should be modified to suit local conditions and the feeds available on each farm as well as the prices of the different feeds. For example, it may be desirable in the South to substitute cottonseed hulls for nonlegume hays or even for legume hay when the price for the hulls makes such a change advisable.

TABLE 6.—*Suggested schedule of increasing feeds in the ration for fattening calves*

Feed	Daily feed per head for first day and at beginning of stated periods										
	First week	Second week	Third week	Fourth week	Second month	Third month	Fourth month	Fifth month	Sixth month	Seventh month	Eighth month
	Lb.	*Lb.*	*Lb.*	*Lb.*	*Lb.*	*Lb.*	*Lb.*	*Lb.*	*Lb.*	*Lb.*	*Lb.*
Corn	3	4	4	5	7	9	10	11	12	13	14
Protein concentrate	¼	½	¾	1	1¼	1¼	1½	2	2	2½	2½
Hay[1]	3	3	3	3	3	3	3	3	3	3	3
Silage	6	8	8	8	8	8	7	7	7	6	5

[1] Preferably legume hay, such as alfalfa, clover, soybean, cowpea, or lespedeza.

It should be understood that it is not necessary to follow exactly the schedules of increases in feeds, as shown in table 6. Some calves are capable of handling increases more rapidly than others. The schedule is a general guide for feeding average calves. It should be noted that roughages are fed in greatest quantities during the first part of the feeding period, and concentrates are increased as the period progresses. However, in the case of long feeding pe-

riods, there may be slight reduction in concentrates during the last month. Older and heavier steers should have correspondingly more concentrates and may be put on a full feed more quickly than calves.

SILAGE FOR SHEEP

By D. A. SPENCER

The use of silage in the winter ration of the flock is increasing. Heretofore many sheepmen have been prejudiced against the use of silage, claiming that it caused abortion and losses of breeding stock. It has been proved by different experiment stations in tests with both breeding and feeder lambs that good silage is an economical as well as valuable part of the ration. Where moldy, decomposed, or too acid silage is fed losses occur, but judicious feeding of good-quality silage improves the health and vitality of the flock.

SILAGE FOR THE BREEDING FLOCK

No cheaper or better roughage can be fed the breeding flock than good corn silage, which furnishes the succulence so necessary for the maintenance of the health and vitality of the ewes.

A good quality of silage is very palatable, and quantities ranging from 1 to 5 pounds per head per day have been fed in different feeding trials with good results. The quantity to be fed depends on the class of sheep and the character of the other feeds comprising the ration. As a rule, however, not more than 4 pounds of silage per head per day should be fed, and some hay always should be in the ration.

Silage shows the best results when fed with a good legume hay. The following has been found to be a good ration for the breeding ewe:

	Pounds
Corn silage	3 to 4
Clover or alfalfa hay	2 to 3

Toward the end of the period of pregnancy it is well to add about one-half to 1 pound of grain to the ewe's ration, thus insuring a strong lamb. If the silage contains a fairly large quantity of grain, however, this increase may not be necessary. If the ewes are in extra-good condition at the beginning of winter and do not lamb until the pasture season opens, grain may be dispensed with. Usually earlier lambing and the use of some grain are found to be more profitable, in the latitude of the Corn Belt and the South.

SILAGE FOR LAMBS

In fattening lambs, corn silage not only takes the place of part of the hay and grain but may reduce the cost of gains.

Care must be exercised in starting lambs on silage. If too much is given at the beginning of the feeding period, the lambs will probably go off feed and scour. To prevent this, offer a small quantity at the start and gradually increase the daily allowance until they are on full feed. Lambs weighing from 50 to 60 pounds should consume about 1.5 pounds of silage per head per day when receiving grain

and hay in addition. Larger quantities of silage can be fed, but some protein supplement, such as linseed or cottonseed cake, should be added to balance the ration.

A fattening ration for lambs that gave excellent results at the Indiana Agricultural Experiment Station is as follows:

	Pounds
Grain (shelled corn, 7 parts; cottonseed meal, 1 part)	1.26
Corn silage	1.40
Clover hay	1.40

In wintering ewe lambs, silage should form an important part of the ration, and when fed in conjunction with a good legume hay it not only keeps the lambs in good condition but furnishes a good growing ration.

SILAGE FOR HORSES AND MULES

By J. O. Williams

Silage is not generally used in horse and mule feeding, but it is a safe feed for either horses or mules if it is of good quality and is carefully fed.

Both horses and mules are peculiarly susceptible to the effects of molds, and under certain conditions varieties of molds are found in silage which are deadly poisons to both of these classes of stock. If the feeder watches the silage carefully as the weather becomes warm, he can soon detect the presence of mold. When mold appears, the feeding should be stopped immediately. Similarly, care should be exercised in the winter feeding of silage so that horses or mules are not allowed to eat frozen silage, because of the danger of colic.

Corn silage is the only kind that so far has met with any degree of favor as a horse or mule feed. Corn which is to be siloed for this purpose should not be cut too green, as sour silage will result, and this may cause colic when fed. Corn for such feed, rather, should be cut when most of the kernels have passed beyond the milk stage.

Silage should not be considered as the principal roughage for horses and mules, but should serve as a partial substitute for hay in the ration. Because of its bulky nature, horses and mules doing hard work should not be fed large quantities, but, owing to its tonic, laxative, and appetizing effects, it is well suited for the maintenance of idle horses and mules, brood mares, and growing stock. The value of silage is greatest, in the case of horses and mules, as a means to carry them through the winter cheaply or to supplement pasture during periods of drought. When used, silage should be introduced gradually into the ration, and the amount fed should generally not exceed from 10 to 15 pounds daily per animal.

ORGANIZATION OF THE UNITED STATES DEPARTMENT OF AGRICULTURE WHEN THIS PUBLICATION WAS LAST PRINTED

Secretary of Agriculture	HENRY A. WALLACE.
Under Secretary	REXFORD G. TUGWELL.
Assistant Secretary	M. L. WILSON.
Director of Extension Work	C. W. WARBURTON.
Director of Personnel	W. W. STOCKBERGER.
Director of Information	M. S. EISENHOWER.
Director of Finance	W. A. JUMP.
Solicitor	MASTIN G. WHITE.
Agricultural Adjustment Administration	CHESTER C. DAVIS, *Administrator.*
Bureau of Agricultural Economics	A. G. BLACK, *Chief.*
Bureau of Agricultural Engineering	S. H. MCCRORY, *Chief.*
Bureau of Animal Industry	JOHN R. MOHLER, *Chief.*
Bureau of Biological Survey	IRA N. GABRIELSON, *Chief.*
Bureau of Chemistry and Soils	H. G. KNIGHT, *Chief.*
Bureau of Dairy Industry	O. E. REED, *Chief.*
Bureau of Entomology and Plant Quarantine	LEE A. STRONG, *Chief.*
Office of Experiment Stations	JAMES T. JARDINE, *Chief.*
Food and Drug Administration	WALTER G. CAMPBELL, *Chief.*
Forest Service	FERDINAND A. SILCOX, *Chief.*
Grain Futures Administration	J. W. T. DUVEL, *Chief*
Bureau of Home Economics	LOUISE STANLEY, *Chief.*
Library	CLARIBEL R. BARNETT, *Librarian.*
Bureau of Plant Industry	FREDERICK D. RICHEY, *Chief.*
Bureau of Public Roads	THOMAS H. MACDONALD, *Chief.*
Soil Conservation Service	H. H. BENNETT, *Chief.*
Weather Bureau	WILLIS R. GREGG, *Chief.*

U. S. GOVERNMENT PRINTING OFFICE: 1935

For sale by the Superintendent of Documents, Washington, D. C. - - - - - - Price 5 cents